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Urban Economics at a Cross-yard: Recent Theoretical and Methodological Directions and Future Challenges

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1. Urban Economics in Regional Science¹

In this paper, our aim is to present a reflection on theoretical and methodological *advances in urban economics* in order to highlight recent and new scientific directions and future challenges. The reasons behind this interest are manifold. The first reason concerns the fact that urban economics is at the core of regional science; it is a strategic discipline whose future trends and developments in theoretical and methodological contributions will be decisive for the future of regional science as a whole, as the basic models in urban location theory of Von Thünen, Alonso, Christaller and Lösch did in the past.

The second reason lies in the fact that the city – or the urban area - is more and more the location or heartland of the major part of the world population, in both developed and developing countries. The city is the cradle of ancient civilization, it is the origin of culture and science, it is the source of industrial development, it is the nodus of any information and communication system, and it is the command centre of a modern network society. But it is also the source of many evils (congestion, criminality, social deprivation and social inequality). Therefore, all negative and positive effects associated with the presence of a high geographical population density are concentrated in metropolises and urban areas, and call for specific spatial-economic analysis to be offered to practitioners and policy makers.

Moreover, the main tendencies generated by the rhythm and by the profound changes in the world economy are exacerbated at the urban level. Cities in developed countries play both the role of gatekeepers towards world markets being the nodes of international infrastructure networks, and the role of loci where competition creates the greatest market tensions (both in input markets, like local labour markets, and in output markets, with strong product competition). Cities in developing countries are both important and problematic realities, being since a long time the recipient of rural unemployment, and thus the locus where the rural crisis generates its negative effects: poverty, social tensions and social diseases, high income inequality, natural resource scarcity, environmental decay, they all mirror unprecedented and dramatic appearances, they are all concentrated in particular territorial settings, and they call for particular attention in spatial economic analysis (Glaeser et al., 1992).

¹ A previous version of the paper was presented at the 43rd ERSA Conference, held in Jyväskylä, 27-30 August 2003. Though the paper is the result of a common work of the two authors, P. Nijkamp has written sec. 4 while R. Capello the remaining sections.

And last but not least, the city is by its very nature the locus where the socio-economic effects caused by a high territorial density of productive and residential activities, manifest all their strengths, and where space plays a fundamental role in generating efficient resource-based production systems. Innovation and learning processes, increasing returns in knowledge and other production factors, and economies of scale in services and infrastructure provision, generated by the simple geographical concentration of activities in space, are all key factors explaining a cumulative self-reinforcing endogenous growth.

Urban economics has always played a central role in the development of regional science. Various pathfinding contributions to spatial economic analysis can be found in the work of Von Thünen, Alonso, Christaller, Lösch, all dealing with location and choice behaviour of firms and residents mainly at the urban level. Also when one envisages contributions in the broader field of spatial development, it appears that many seminal works were conducted at the urban level, like the Hoyt model (Hoyt 1954), born as an urban planning tool and, therefore, as a spatial model of physical urban growth. Once again, considering methodological tools, the same kind of conclusion emerges; the first applications of gravity (and more recently entropy) models have mainly taken place at the urban level and were developed in order to solve practical urban problems (e.g. spatial interaction within cities, and consequent infrastructure planning).

One can identify the reasons for this strategic role of urban economics as follows. The first argument lies in the nature of the city itself, being a complex system where social, economic and environmental aspects interact and define urban physical and economic growth patterns. Therefore, if the field of regional science is conceived of as a cooperative venture among distinct spatially-oriented disciplines, this is even more true for urban phenomena; a single discipline such as geography, economics, or political science cannot provide the basis for a comprehensive understanding of a city, in all its social and economic complexity.

The second reason for the strategic role played by urban economics within regional science is that, given the economies of density of residential and productive activities, the territorial principles governing the spatial organisation of activities, stated clearly by Camagni for the first time (Camagni, 1992), are strongly manifested at the urban level, in particular:

- the high density of population and productive activity prompts all positive (and negative) phenomena stemming from physical proximity; agglomeration economies, in the form of both urbanisation and localisation economies, are recognised to be one of the genetic elements in the existence of cities (*agglomeration principle*);
- the understanding of mutual interaction between transport costs and land use finds its first immediate and more rational application at the urban level (*accessibility principle*);
- the high density of residential and productive activities present in cities facilitates the needs for contacts, and consequently the spatial interaction mechanisms, with all positive and negative effects associated with them (*spatial interaction principle*);
- the spatial division of labour is clearly reflected in the socio-economic disparity patterns among different cities (*urban hierarchy principle*);
- as cities are the major location of productive activities, competitiveness is highly important at the urban level, and calls for specific provisions in favour of urban efficiency mechanisms (*competitiveness principle*).

Clearly, these principles may be mutually complementary, but they may also be mutually conflicting. The recognition of the importance and development of proper theories and methods in

the field of urban economics is therefore an important means to understand both as yet existing bottlenecks and future possible directions in urban economics.

With a view to the prominent position of modern cities in a global network economy, the focus of this review paper is on urban economics as a sub-discipline of regional science. The aims of the paper are:

- to provide an overview of recent developments in both theoretical and methodological reflections in the field of urban economics (Sections 2 and 3);
- to explore the role these reflections in urban economics may play in re-launching regional science as a whole and to identify future development patterns (Section 4);
- to highlight future challenges (Section 5).

Some concluding remarks are contained in Section 6.

2. Recent Theoretical Directions

Although regional science is a relatively young discipline, in its fifty years of existence a surprisingly large variety of theories, methods and models have been developed which provide a relatively comprehensive theoretical and methodological toolbox for spatial analysis. Urban economics is not an exception in this respect; contemporary urban economics records in fact many advances and even breakthrough achievements, which enrich and reinforce both the theoretical and empirical frameworks of spatial analysis².

A great deal of our present understanding of the fundamental interaction between space and local economic behaviours originates from the fields of location theory and urban economics; the great number of relatively new and advanced contributions in this field does not allow for a detailed review on all individual achievements made; in addition, a disaggregated analysis of all novelties would probably not be so stimulating. We feel that an attempt to highlight general tendencies, at both a theoretical and methodological level, will turn out to be more fruitful for a debate on present weaknesses and on possible future directions of urban economics (see also Table 1). Inevitably, the set of “tendencies” that follows is both selective and incomplete, primarily reflecting our own views and research interests.

By looking at the theoretical trajectories followed in urban economics, one of the major tendencies which has accompanied the theoretical development in the field is the *need for more realism* in sometimes rather abstract conceptual approaches, by relaxing most of the glaring unrealistic assumptions of the basic theoretical models. This tendency is justified by the need to broaden the interpretative capacity of the theoretical toolbox in this research field by searching for theories that are better able to reflect the real world.

In the context of the agglomeration principle, the need for more realism has led to the recognition that city size cannot be interpreted on the basis of an “optimal city size”, but of an “efficient size”, which depends on the functional characteristics of the city and on the spatial organisation within the urban system. Economies of scale exist up to a certain city size. However, urban development generates conditions leading to structural readjustments which may create new economic advantages. These structural adjustments may either be sectoral transformations towards higher order functions, or the increase of external linkages with other cities. Therefore, these new

² Advances reflections in both theoretical and methodological aspects in Urban Economics are contained in Capello and Nijkamp (eds.) (2004).

perspectives were inclined to accept what Richardson had already emphasised some years ago (Richardson, 1972), namely that, beyond size, in the real world most cities differ in terms of functional specialisation and of spatial organisation. Moreover, decisive steps forward have been made by accepting that environmental aspects (both positive and negative) are intrinsic and intertwined elements of agglomeration economies, contributing to the definition of urban attractiveness, urban growth and degree of competitiveness (Roback, 1982). An important conceptual step forward has been provided by the acceptance that physical proximity cannot be the source for all advantages of an urban location, and that relational proximity, i.e. the degree of social interaction, and sense of belonging (called “social capital” in the social sciences), can sometimes have a greater interpretative power on urban dynamics than the advantages obtained by the mere physical proximity.

The area where the need of realism has strongly been felt is in land use and in location choice models, explaining the competition that derives among activities to obtain the most central location in a city. The analysis of economic behaviour in space represents the core of urban economics; extensions and refinements of the basic Von Thünen-Alonso-Muth work, in which at equilibrium a marginal reduction in rent from further decentralisation was exactly offset by a marginal increase in travel costs, defining a condition of indifference among locations (the famous “Muth condition”), led to the birth of established a particular sub-discipline; all advanced models in this direction can be interpreted under the label “New Urban Economics”, and more recently “Analytical Urban Economics”³. The development trajectory in this branch of urban economics has been the relaxation of the simple assumptions made in the basic models; the introduction of income differences in location choices, of randomly distributed idiosyncratic tastes, of heterogeneous urban space and of the existence of externalities in the use of land (congestion, zoning, segregation, fiscal jurisdictions) are some examples in this respect⁴. The result achieved has been a higher degree of realism in the models, at the expense of a higher level of analytical sophistication, highly criticised when giving birth to a pure “l’art pour l’art” attitude so detrimental to further acceptance and advances in this branch of urban economics.

In spatial interaction models, a great deal of effort has also been devoted to the introduction of various more realistic assumptions. Recent analyses and models contain both competing destination and intervening opportunity factors (Fortheringham, 1983). Attempts to make interaction models more realistic are also developed by considering possible alternative paths between nodes. When congestion requires a path different than the off-peal ideal, the intervening opportunities along the alternative path are taken into consideration (Fischer and Getis, 1999). An important breakthrough has been the establishment of a consistent link between spatial interaction models and behavioural discrete choice models (see Nijkamp and Reggiani, 1999).

In the study of urban hierarchy, two main directions have been followed in new theoretical contributions. The first attempt is to insert more realism into the two pathfinding models of Christaller and Lösch, by relaxing strong assumptions regarding the homogeneous demand distribution (Beckman and McPherson, 1970) and non-existence of location and production choice interdependencies (Long, 1971; Beguin, 1988). In this respect, the pioneeristic attempt of Long to introduce in the Christaller model the interdependence of goods demonstrates that the honeycomb structure achieved by Christaller strongly depends on the assumption of no interdependence in production and demand, although the mathematical complexity of the Long model does not allow for analytical solutions. More recently, the interpretation of new economic relationships among cities, primarily based on cooperative and horizontal relationships, has required to break the conceptual approach of urban hierarchy, and generated a new interpretative paradigm, that of “city

³ See Richardson et al., 1996.

⁴ The volume edited by Richardson et al. (1996) contains a very comprehensive set of papers on this issue.

networks” (Camagni, 1993). The most important theoretical novelty provided by this paradigm is the break of the link between urban size and urban functions imposed by the Christallerian logic. With Christaller’s approach, it is in fact impossible to explain why a city like Zurich, with only 300,000 inhabitants, is specialised in international finance in the same way as the city of New York or Tokyo. In the real world, the urban size is not always characteristic of core functions.

Last, but not least, in theories dealing with urban competitiveness, decisive developments have been made with regard to the understanding of endogenous determinants of urban growth. The question of whether a city (or a region) is intrinsically capable of growing as a result of endogenous forces has been a source of debate for decades; industrial specialisation, infrastructure endowment, central location, production factor endowment, or agglomeration economies have alternatively been emphasised in the academic arena as driving forces of local economic success. The decisive step forward in this field has been the focus on economies of scale in production which, together with non-linear transportation costs, are introduced into a (quantitative) interregional growth model; the final spatial distribution of activities critically depends on initial conditions including the starting distribution of activities and the nature of the non-linearities embedded in the activity-transportation interactions, which give rise to multiple equilibria (Krugman, 1991). The additional value of Krugman’s approach resides in skilfully modelling the interaction between transportation costs and economies of scale in production, although the determinants of endogenous growth have already since long been emphasised, starting from the Myrdal-Kaldor model (increasing returns, cumulative self-reinforcing growth patterns). In parallel to Krugman’s efforts, in the field of endogenous determinants a great emphasis has recently been put on knowledge as a driving force to development, and, what is really new, on the endogenous self-reinforcing mechanisms of knowledge creation. Macroeconomic models of endogenous growth (where knowledge is generally embedded in human capital) (Romer, 1986; Lucas, 1988), as well as in microeconomic models, where knowledge creation is analysed in terms of learning processes (at institutional, at territorial and at firms’ level) have widely dominated the academic arena in the last decade.

A second clear tendency in theoretical developments in urban economics has been the attempts to move towards *dynamic approaches*. Time matters as well as space in regional science, and this also holds in urban economics. The effort to encapsulate time in spatial analyses has taken place in two different ways, according to two different meanings of time: a more traditional chronological time, and time as rhythm of innovative phenomena which occur in the territory. The introduction of a chronological time within spatial analysis is not at all a simple task, since it requires a mathematical and methodological toolbox, only recently available to regional scientists, with which we will deal in the section devoted to methods and modelling. Theories on non-linear urban dynamics – framed in the context of chaos theory, synergetics theory or predator-prey analysis - may be mentioned here (see Nijkamp and Reggiani, 1999).

Conceptually speaking, time has also entered theoretical reflections on cities through the concept of innovation; time à la Bergson-Heidegger is interpreted as duration and a continuous process of creation, characterised by discontinuity, irreversibility, sequentiality and cumulativeness. Time has thus been conceived by an important part of urban studies as the pace of learning, innovation and creation processes. Cities are by definition the loci where learning and cumulative learning processes take place; the identification of the sources and of the endogenous determinants of such processes, besides simple physical proximity, represents a great challenge for urban economists. Knowledge spillovers, collective learning, learning regions (or learning space) are all theories that embrace the most advanced perspectives in this direction⁵.

⁵ In these fields of research, see among others Anselin et al., 1997 and 2000; Audretsch and Feldman 1996; Aydalot, 1986; Camagni, 1991 and 1999; Capello, 1999 and 2001; Crevoisier and Camagni, 2000; De Groot et al., 2001;

3. Recent Methodological Directions

Parallel to the theoretical reflections underlined above, a series of advances can be highlighted in the fields of models and methods, which are here grouped in two major tendencies: refinements and advances in operational models and techniques, accompanied by a clear tendency to prove the theoretical reflections through quantitative measures.

In terms of *refinements of models and methods*, in the sphere of physical city growth, a particular paradigm has received a great deal of attention in the modelling literature of the eighties, based on the competition (substitution/complementarity) among populations in a space-economy network, generally formalised by means of (bio) ecologically-based models. An important property of these models is that they allow oscillating and chaotic behaviour, like the previous non-linear models, with which they are strongly connected (Van Geenhuizen and Nijkamp, 1996). More recently, the Lotka-Volterra (or prey-predator) model has been reformulated in order to explain urban dynamics through the relative dynamics of land rents (Camagni, 1992). Urban rent is interpreted as a share of total income; the substitution link between production profits and urban rent (the former decrease when the latter increases) generates, as a consequence, a decrease in investments, limiting economic growth in the urban area concerned. In this version of the model, urban rent therefore plays the role of spatial resource allocator, since it influences location choices: an increase in urban rent pushes residential and production activities towards the periphery, which is characterised by lower land prices⁶.

The area of location decisions has witnessed more theoretical advances than new applications, being the greatest steps forward made in theoretical modelling, with high a degree of abstraction and analytical complexity. However, recent locational analysis is increasingly based on disaggregated models of choice: logit and probit models have widely been applied in this field, which give rise to a much more refined analysis, since they allow to take into account various individual locational determinants, including qualitative factors. In this context, a new interest in spatial computable general equilibrium models can be observed.

In spatial interaction, a great deal of effort has been devoted to the explanation of the reasons behind the strong interpretative power of gravity models on urban phenomena. At least, three theoretical foundations have been developed for this family of models: entropy maximisation, random utility, and finally models based on neurocomputing principles that represent a recent innovation in the design of spatial interaction models (Griffith, 1999; Fischer and Reggiani, 2004). Wilson (1970 and 2000) introduced the entropy maximising theory supporting spatial interaction models, later extended by many others (see for example, Snickars and Weibull, 1977; Roy and Lesse, 1981, and Smith, 1988). The fundamental assumption is that at the outset all outcomes are equally likely. The number of outcomes is a combinatorial problem, counting the number of ways of assigning the total number of flows to all possible origin-destination pairs. Maximising this function identifies the most probably geographic patterns that are consistent with origin-destinations, and/or average distance travel. The entropy maximizing approach was followed by a host of alternative derivations. The most important is the choice-theoretic approach that was first proposed by Niedercorn and Bechdolt (1969) and has generated a great deal of interest since then⁷.

Feldman, 1994; Feldman and Audretsch, 1999; Jaffe, 1989; Jaffe et al. 1993; Maier and Sedlacek, 2005; Maillat et al., 1993; Maskell and Malmberg, 1999; Rallet, 1993; Ratti et al. 1997; RERU, 1999.

⁶ Recently Capello and Faggian (2002) applied this model to the Italian urban system.

⁷ See Golob and Beckmann, 1971; Choukroun, 1975; Nijkamp, 1975; Smith, 1975, 1978; Batten and Boyce, 1986; Fotheringham and O'Kelly, 1989; Fotheringham, Brunsdon and Charlton, 2000.

The essential idea of this approach is to model spatial interaction behaviour within the microeconomic paradigm of random utility maximizing choice behaviour. More recently, the emergence of GeoComputation as a subject (see Longley et al., 1998; Fischer and Leung, 2001) and the powerful and fast computing environment has inspired many scholars to apply neurocomputing principles and techniques to revisit old and to solve new spatial interaction problems. The interaction models derived are given a very general formulation represented in the form of specific neural networks and viewed as universal function approximators (Fischer and Reggiani, forthcoming).

A clear new evolution in Christaller and Lösch's basic models is linked to attempts to present a dynamic picture of an urban hierarchy, and the work of Parr is a breakthrough in this respect (Parr, 1978, 1981, 1985). Starting from the honeycomb structure of Christaller, Parr analyses the evolution of the spatial organisation of the urban hierarchy when some external effects occur, like the change in the allocation of economic functions at different hierarchical levels, or the creation of different lower-order levels in the hierarchical structure. The result achieved is that the hexagonal structure of Christaller modifies into rectangular, triangular or varying hexagonal forms along the urban hierarchy.

In growth models, until a few years ago, the large majority of experiments and applications has taken for granted the existence of linear – and thus regular – growth processes. Linear models are certainly able to generate unstable solutions, but the solutions of such models are restricted to certain regular standard types. Such models may provide approximate replications of short- and medium-run changes, but fail to encapsulate long-term developments characterised by structural shifts of an irregular nature. This limit has recently been overcome with the adoption of non-linear models, which allow for a change in the dynamics of a system generated even by small perturbations in structural forms; structural instability means the possible existence of significant qualitative changes in the behaviour of the system (i.e. in the state variables) that are closely connected with bifurcation and catastrophe phenomena that can occur if the parameter values (i.e. the control variable) are changing. The application of non-linear models to the well known neoclassical and Keynesian models has shown that the deterministic and unique results achieved by the dynamic linear models are no longer guaranteed: interregional income convergence determined by the traditional neoclassical model collapses and opens the way to alternative possible trajectories, and equilibria solutions; non-linear Keynesian Myrdal-Kaldor models substitute the deterministic result of continuous growth or decline with new and opposite development trajectories, after a catastrophe phenomena occur (Miyao, 1984, 1987a and 1987b).

A second clear tendency in models and methods is the *interest in quantitative measures*. Econometric and statistical tools have in fact exerted a dominant influence on regional and urban economics. In the past several statistical methods have been developed for dealing with regional and urban data, such as cluster techniques, principal component analysis, spatial autocorrelation analysis, spectral analysis, and so on (Nijkamp and Mills, 1986). The “quantitative” revolution in economics has no doubt exerted a significant impact on the methodology of regional science as a whole. In urban economics this has led to the possibility to “measure the unmeasurable”: examples are dynamic urban economies, urban milieu effects, environmental externalities in cities, social costs of alternative land use patterns, city network advantages, knowledge spillovers, collective learning processes have been measured; the results achieved provide robust empirical evidence for policy makers and practitioners. Developments in the field of geographic information systems – also in the urban field – are complementing this development.

4. Urban Economics and Regional Science Transition

The theoretical and methodological development in Urban Economics, and in general in Regional Science, has not always been a smooth and constant process. During the nineties a wide debate was launched around the idea of a possible “mid-life crisis”, reached after forty years since the establishment of regional science as a discipline; the assessment of the path that led from there to here, a comparison of the aims achieved with those expected, and the exploration of new possibilities for the future were the main aims of the various reflections and evaluations that from different perspectives were addressed to regional science (Bailly, 1992; Bailly and Coffey, 1994; Funck, 1991; Isserman, 1993, 1995; van Geenhuizen and Nijkamp, 1996).

The debate on the difficulties encountered by the development of regional science was useful to identify two sources of problems: the lack of relevance on practical problems, on the one side, and the loss of interdisciplinarity, on the other. The first was signalled as the result of the tendency of that period to develop descriptive or analytical tools and models, which “had the sweet and intoxicating flavour of *l’art pour l’art*” (Bolton and Jensen, 1995, p. 137). The second source of malaise was related to the somewhat ironic recognition that, despite openness and breadth – in terms of disciplines, methods and objects of analysis – were the major goals to which the field aspired in its early days, in the nineties the major weakness of regional science was its narrowness of perspective (Bailly and Coffey, 1994). We may now appreciate that these phenomena may not be regarded as “crisis signs”, but as normal transition phenomena reflecting a sound dynamics of the discipline. Science – including Regional and Urban Science – goes through the normal upswings and downswings of a ‘scientific product life cycle’.

Urban economics, as an important branch of regional science, played certainly at that time a crucial role in that critical re-orientation. One of the fields of major divergence between regional science and practice is in the field of behavioural choices and location models, where the degree of analytical complexity is in some models so high that the role theoretical models should have to provide a coherent framework within which to think about empirical issues was lost. Moreover, the attitude to provide classic mainstream economic models to the analysis of location choices and spatial behaviour has heavily provided a divergence from traditionally more interdisciplinary oriented models and approaches of regional science.

Nowadays, we recognise that the field of regional science is changing, especially for what concerns the need to reduce the unfortunate discrepancy between regional science and practice, mainly due to urban economics. The reason behind this feeling stems from the emphasis put on some recent and updated research fields in urban economics; two examples in this respect are, on the one side, the important consideration of urban environmental problems, and on the other, the interest in capturing sources of endogenous urban competitiveness, with the aim to guarantee economic and social growth.

Urban sustainability is nowadays a major field of research, dealing with problems of efficient natural resource consumption, with negative environmental externalities, but also with a larger concern on urban quality of life. Social, economic and environmental problems are taken into consideration in the analysis of quality of life. After the avalanche of interest in global environmental issues (see e.g. the Brundtland Report or the Report of the World Commission on Environment and Development (WCED 1987), the awareness has grown that many environmental problems have a local origin, while also global environmental decay often manifests itself at a local level. Thus, there is a simultaneous need for local action and global reflection. Consequently, cities may act as focal points for creative environmental strategies (see also Stanners and Bordeau 1995). This holds for both the industrial and the developing world.

Urban sustainability as a field of research can also offer an opportunity to overcome the second malaise encountered in regional science, that of loss of multidisciplinary: in fact, environmental problems are not only a subject for economic reflections. They call for a multidisciplinary approach, from economics to urban planning, from biology to ecology. There are in fact many ways for a simultaneous analytical treatment of economics and environment. Since the 1960s a great many attempts has been made to link the economy to the ecology (Costanza et al. 1997). An important contribution to the integration of economics and ecology began simply with a reflection on the principles of the materials balance for resources (extracted or collected, transformed, consumed and emitted) and on the need to take account of an economic viewpoint of such processes (Ayres et al. 1999). Several attempts have also been made to build economic and social accounting systems that could incorporate the measurement of economic welfare and performance together with the measurement of environmental indicators and performances. The integration of economics with ecology has also been approached from the viewpoint of land-use - where economic and ecological processes have the most disruptive effects - and of urban environments. In addition, the interaction between economic and ecology has been dealt with for situations with global risks and uncertainties.

Even the second field which is more and more in the agenda of urban scientists, that of the identification of the determinants of urban competitiveness and growth, presents in some respects a good opportunity for regional science to recover from the diseases emphasised in the nineties. It replies to the more and more stringent need of practitioners and policy makers to build efficient urban systems. As mentioned in the ESPD document, firstly written on the occasion of the European Ministers Council meeting in Noordwijk in 1997, and revised at the meeting in Glasgow, in June 1999, "The development of Europe's cities and the relations between them constitutes the most important factor affecting the spatial balance of the territory of Europe" (ESDP, 1998, p. 47) and, moreover, "regions as a whole can become competitive only if their towns and cities are motors of economic growth" (ESPD, p. 51).

Moreover, within the Lisbon European Council of March 2000, the strategic goal for the next decade for Europe is "to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion". This has become known as the "Lisbon strategy" or the "Lisbon agenda"; technological upgrading, a dynamic entrepreneurship (facing international competition) and migration (contrasting the trend in population aging) are interpreted as the main driving forces for future competitive scenarios. Cities are the main territories in which these driving forces can develop and generate competitive advantages for the national economies.

Cities are in fact the fireplace of economic activity; they generate new life in the economic system through their agglomeration forces which induce innovative and competitive business strategies and new life styles. A prominent role in the ongoing urban transformation is nowadays played by the modern information and communication technologies (ICT) sector. ICT may be regarded as a collection of digital technologies and applications that enable the processing, storage and transfer of information to a wide variety of users. The unprecedented potential of ICT has created new visions on the future of cities, as is e.g. witnessed by the concept of a 'global village' (see for a review Graham and Marvin, 1996).

In recent years, a large body of literature on the relationship between ICT and the city has emerged. Many studies address the structural impacts of ICT on the social and economic fabric of the city. For example, the 'death of distance' hypothesis led researchers to believe that the city in a high-tech age might vanish (see e.g. Toffler, 1981). But more recently, the conviction has grown that the attractiveness of large cities has not declined, but even grown as a result of modern ICT (see

Glaeser, 1998). The reason is that ICT may be a very effective tool in reinforcing the agglomeration potential of a modern city, by attracting high-tech and innovative firms. ICT is also offering many new opportunities for urban areas, such as telecommuting centres, information offices for SMEs, or web-based facilities for the creative industry. And furthermore, ICT is increasingly playing a role in urban planning and policy-making (see for an overview Cohen et al., 2004). There is clearly much scope for further research on the intricate linkage between the ICT sector and the urban economy.

Moreover, the city has been the cradle of entrepreneurship. Historically, this has been the market place where new ideas – instigated by a critical mass of a diversified demand, new risk-taking opportunities and external contacts and trade – were transformed into innovative action. The urban climate has often acted as a package of incubation conditions for creative entrepreneurship (see e.g., Davelaar and Nijkamp, 1997; McCann, 2001; Neary, 2000). Urban agglomeration conditions and innovative entrepreneurship are mutually reinforcing forces.

It is thus undoubtedly true that the ‘entrepreneurial hero’ has played a central role in urban economic development. The relationship between innovation, entrepreneurship and urban economic attraction forces has in recent years gained much interest, in both the research and the policy world. Much interest has emerged in the space-time geography of urban innovations in a broader (sometimes global) network setting, in the identification of organizational and technological conditions for local entrepreneurship and local market niches, the implications of a varied local labour market for self-employment and ethnic entrepreneurship, and so forth (see e.g., Bridge et al, 2003).

Clearly, in many cases much attention has been given to the new potential offered by the ICT sector, not only from the angle of hardware or software, but also from the perspective of new organizational modes of production. The design and adoption of new technologies has called for due interest in conditioning factors such as receptivity, trust and entrepreneurial culture (see Kotkin, 2000; Murphy et al., 1991).

Last, but not least, our age is the age of migration, especially towards Western countries (Castles & Miller, 2003). Many migrants have moved to urban agglomerations, because of the abundance of expected socio-economic opportunities in large cities. Migration was not only selective in terms of the distribution between urban and rural areas, it was also selective in terms of the choice of specific cities or urban districts. Network formation appeared to be a major-driving force for ethnic clustering in all major cities (e.g. Carliner, 2000; Borjas, 1999). Even though a large influx of people with a different socio-economic background and different – often lower – skills, may create the conditions for an urban dual labour market, in many cases the rise in variety in urban labour markets may generate a large pool of employment opportunities that may favour business life in the city. Consequently, a major challenge for urban economic development policy in an open world is to create a balanced package of employment conditions.

Interestingly enough, while it seems to us that in the field of urban economics, regional scientists are spontaneously moving towards much more practical problems, it also seems that practitioners and policy makers at different governmental levels are calling for more and more attention at the local, and particularly urban, level. It is a great chance offered to urban scientists, a chance to recover from previous “diseases” and to relaunch the field of regional science as a strategic area of research, not only in academic, but also in policy making, arenas. Whether this is the case, depends strongly on the way regional and urban scientists will react to this opportunity.

5. Future Challenges

Our impression on the future of urban economics (and regional science in general) is optimistic. After a period of reflection, regional science shows clear signs of recovery, such as a deep interest in practical problems, and the recognition that an “art pour l’art” approach is detrimental to further acceptance and advances in this field.

However, we still envisage some risks for what concerns the lack of interdisciplinarity. Since the time this problem has been underlined (Bailly and Coffey, 1994), hardly any signs of recovery can be identified, and we feel that the situation has become even more problematic. This pessimistic interpretation is based on some clear tendencies encountered in some recent theoretical developments, where some wide fields of unexplored interdisciplinarity still exist and no tendency to fill them seems to show up.

Some examples are useful in this respect. The theory on “social capital” developed by quantitative sociology is an example in this respect: the concept could take advantage from and provide advantage to all reflections on local synergies and milieu effects developed by regional and urban economists, and by the strategic planning studies in the field of urban planning (Camagni, 2002). The reflections in the field of knowledge spillovers developed by industrial economists could take advantage from the concepts of collective learning and relational proximity of regional scientists, in which the endogenous spatial development patterns of knowledge are not left to simple probabilistic contacts, but explained through territorial processes (Camagni and Capello, 2002). Last but not least, the theoretical reflections characterising the “new economic geography” seem to be the result of a skilful effort of a group of mainstream economists, driven however by a somehow unexplainable attitude to deny the importance of well known spatial concepts (i.e. technological spatial externalities), or to (re-) invent important spatial concepts (i.e. cumulative self-reinforcing processes of growth; transportation costs vs. agglomeration economies in location choices). The inevitable consequence of such attitude is to mix the important and undeniable steps forward made by the “new economic geography” school with already well-known knowledge in the field of regional science.

Some risks of disciplinary barriers and of closeness to interdisciplinary views on strategic problems are still there. They are the result of a regional scientists’ narrow perspective, as mentioned by Bailly and Coffey (1994), but also on some idiosyncratic approaches of mainstream disciplines towards a clearly multidisciplinary science like regional science. Especially in the case of economics, we hope that after the (re-)discovered interest by mainstream economists of space, and of spatial phenomena, the attitude towards regional science changes in favour of a more cooperative attitude and pronounced interest.

6. Conclusions

Cities are the natural loci for economic development, loci where all tensions associated with fast growing (globalising) economies in developed countries emerge, and where all social and economic tensions of high unemployment in developing countries take place, and therefore represent important areas to where practitioners and policy makers require a sophisticated and advanced toolbox to intervene.

Urban economics has been subject to wide and creative advances in terms of both theoretical and methodological contributions. Some main tendencies in the development trajectories of the discipline have been stressed in this review, and in particular the attempt to introduce more realism into the theoretical approaches. This effort is worth the effort; in the last fifty years urban

economics has achieved sophisticated theoretical models able to provide a coherent framework within which to think about empirical issues. Sometimes, this effort has been pushed too far, by generating analytical tools and models which had the intoxicating flavour of “l’art pour l’art”, and by prompting regional science in driving away from its nature of combining rigorous theoretical reflections with an understanding of place realism.

Urban economics has undoubtedly played a role during the nineties in driving regional science towards its “crisis”. By regarding this “crisis” as a transition phenomenon, it is also evident in our perspective that in these days urban economics is in front of a cross-yard: it has the opportunity to convert the trend by encouraging regional science to reduce the unfortunate and unproductive divergence between theoretical approaches and practices.

Cities call in fact for specific attention by policy-makers who foresee in efficient urban systems the key of success for economic growth of territories. At the same time, regional scientists present in their scientific agendas a particular interest in problems that have a strong practical contour: urban sustainability, on the one side, and endogenous determinants of urban growth (like knowledge creation), on the other. These two themes have both a practical interest and a need for a multidisciplinary approach, providing regional scientists with all prerequisites to identify new pathways. Whether this happens, is a matter of willingness to grasp the opportunities that are provided in this period, and to reply to the plea of policy-makers for a more locally oriented understanding of real world.

Clearly, some research challenges faced and opportunities offered are not yet grasped. We still envisage the tendency to develop some research themes with a strong disciplinary focus, while neglecting a cooperative attitude and a cross-fertilisation of ideas among scientists of different disciplines. Our impression is that serious efforts should be made in this respect in order to take advantages of all synergies brought about by a cooperative attitude.

Bibliographical References

- Anselin L., Varga A. and Acs Z. (1997), “Local Geographic Spillovers between University Research and High Technology Innovations”, *Journal of Urban Economics*, vol. 42, pp. 422-448
- Anselin L., Varga A. and Acs Z. (2000), “Geographic and Sectoral Characteristics of Academic Knowledge Externalities”, *Papers in Regional Science*, vol. 79, n. 4, pp. 435-443
- Audretsch D. and Feldman, M. (1996), “R&D Spillovers and the Geography of Innovation and Production”, *American Economic Review*, vol. 86, 3, 630-640
- Aydalot Ph. (eds.) (1986), *Milieux Innovateurs en Europe*, GREMI, Paris
- Ayres R. U., Button K. and Nijkamp P. (eds.) (1999), *Global Aspects of the Environment*, vol. 1 and 2, Edward Elgar, Cheltenham, UK
- Bailly A. (1992), “Representation et Analyse des Territoires: une Epistemologie de la Science Regionale”, in Derycke P. H. (ed.), *Espace et dynamique territoriale*, Economica, Paris
- Bailly H. and Coffey W. (1994), “Regional Science in Crisis: a Plea for a More Open and Relevant Approach”, *Papers in Regional Science*, vol 73, n. 1, pp.3-14
- Batten, D.F. and Boyce, D.E. (1986) “Spatial Interaction, Transportation, and Interregional Commodity Flow Models”, in Nijkamp, P. (ed.), *Handbook of Regional and Urban Economics, Volume I*. North-Holland, Amsterdam, pp. 357-406
- Beckmann M.J. and Mc Pherson J. (1970), “City Size Distribution in a Central Place Hierarchy: an Alternative Approach”, *Journal of Regional Science*, vol. 10, pp. 25-33
- Beguín H. (1988), “La Région et les Lieux Centraux”, in Ponsard C. (a cura di), *Analyse Economique Spatiale*, Presse Universitaire de France, Paris, pp. 231-275
- Bolton R. and Jensen R. C. (1995), “Regional Science and Regional Practice”, *International Regional Science Review*, vol. 18, n. 2, pp. 133-145
- Borjas G. J. (1999), *Heaven’s Door*, Princeton University Press, Princeton

- Bridge, S., O'Neil K. and Cromie S. (2003), *Understanding Enterprise, Entrepreneurship and Small Business*, Palgrave MacMillen, Basingstoke
- Camagni R. (1991), "Local "Milieu", Uncertainty and Innovation Networks: Towards a New Dynamic Theory of Economic Space", in Camagni R. (ed.), *Innovation Networks: Spatial Perspectives*, Belhaven-Pinter, London, pp. 121-144
- Camagni R. (1992), *Economia Urbana*, Nuova Italia Scientifica, Rome
- Camagni R. (1993), "From City Hierarchy to City Networks: Reflections about the an Emerging Paradigm", in Lakshmanan T.R. and Nijkamp P. (eds.), *Structure and Change in the Space Economy: Festschrift in honor of Martin Beckmann*, Springer Verlag, Berlin, pp. 66-87
- Camagni R. (1999), "The City as a Milieu: Applying the Gremi Approach to Urban Evolution", *Révue d'Economie Régionale et Urbaine*, n. 3, pp. 591-606
- Camagni R. (2002), "Interdisciplinarieta e Multidisciplinarieta nelle Scienze Regionali", paper presented at the Seminar on "The Future of Regional Science", held in Turin, 31st may
- Camagni R. and Capello R. (2002), "Apprendimento Collettivo, Innovazione e Contesto Locale", in Camagni R. and Capello R. (eds.), *Apprendimento Collettivo e Competitivita Territoriale*, Franco Angeli, Milano, pp. 11-26
- Capello R. (1999), "Spatial Transfer of Knowledge in High-technology Milieux: Learning vs. Collective Learning Processes", *Regional Studies*, Vol. 33, n. 4, pp. 353-365
- Capello R. (2001), "Urban Innovation and Collective Learning: Theory and Evidence from Five Metropolitan Cities in Europe", in Fischer M.M. and J. Froehlich (eds.), *Knowledge, Complexity and Innovation Systems*, Springer, Berlin, Heidelberg, New York, pp. 181-208
- Capello R. and Faggian A. (2002), "An Economic-ecological Model of Urban Growth and Urban Externalities: Empirical Evidence from Italy", *Ecological Economics*, 40, 2, pp. 181 – 198
- Capello R. and Nijkamp P. (eds.) (2004), *Urban Dynamics and Growth: Advances in Urban Economics*, Elsevier, Amsterdam
- Carliner G. (2000), "The Language Ability of US Immigrants", *International Migration Review*, vol. 32, pp. 158-182.
- Castles S. and Miller M.J. (2003), *The Age of Migration*, Guildford Press, New York
- Choukroun, J.M. (1975), "A General Framework for the Development of Gravity-type Distribution Models", *Regional Science and Urban Economics* 5, 177-202
- Cohen G., Nijkamp P. and van Montfort K. (2004), "Modelling ICT perceptions and Views of Urban Front-liners", *Urban Studies*, vol. 41, no. 13, pp. 2647-2667
- Costanza R., Perrings C. and Cleveland C.J. (eds.) (1997), *The Development of Ecological Economics*, Edward Elgar, Cheltenham, UK
- Crevoisier O. and Camagni R. (eds.) (2000), *Les Milieux Urbains: Innovation, Systèmes de Production et Ancrage*, EDES, Neuchâtel
- Davelaar E.J. and Nijkamp P. (1997), "Spatial Dispersion of Technological Innovation: a Review", in Bertuglia C.S., Lombardo S. and Nijkamp P. (eds.), *Innovative Behaviour in Space and Time*, Springer-Verlag, Berlin, pp. 17-40
- De Groot H., Nijkamp P. and Acs Z. (2001), "Knowledge Spill-overs, Innovation and Regional Development", special issue, *Papers in Regional Science*, vol. 80, n. 3
- ESDP–European Spatial Development Perspective (1998), complete version, Glasgow, 8 June
- Feldman M. (1994), *The Geography of Innovation*, Kluwer Academic, Boston
- Feldman M. and Audretsch D. (1999), "Innovation in Cities: Science-based Diversity, Specialisation and Localised Competition", *European Economic Review*, Vol. 43, pp. 409-429
- Fischer M. M. and Getis A. (1999), "New Advances in Spatial Interaction Theory", special issue of the *Papers in Regional Science*, vol. 78, n. 2
- Fischer M. M. and Reggiani A. (2004), "Spatial Interaction Models: from the Gravity to the Neural Network Approach", in Capello R. and Nijkamp P. (eds.), *Urban Dynamics and Growth: Advances in Urban Economics*, Elsevier, Amsterdam, pp. 319-346
- Fischer M.M. and Y. Leung (eds.) (2001), *GeoComputational Modelling: Techniques and Applications*, Springer, Berlin, Heidelberg and New York
- Fotheringham A.S. (1983), "A New Set of Spatial Interaction Models: The Theory of Competing Destinations", *Environment and Planning A*, vol. 15, pp. 15-56
- Fotheringham A.S. and O'Kelly, M.E. (1989), *Spatial Interaction Models: Formulations and Applications*, Kluwer, Dordrecht, Boston and London

- Fotheringham A.S., Brunsdon C. and Charlton M. (2000), *Quantitative Geography. Perspectives on Spatial Data Analysis*, Sag Longley P.A., Brocks S.M., McDonnell R. and MacMillan B. (eds.) (1998), *GeoComputation: A Primer*, John Wiley, Chichester
- Funck R. (1991), "Regional Science in Transition", *Papers in Regional Science*, vol. 70, pp. 1-8
- Geenhuizen van M. and Nijkamp P. (1996), "Progress in Regional Science: a European Perspective", *International Regional Science Review*, vol. 19, n. 3, pp. 223-246
- Glaeser E., Kallal H., Scheikman J. and Shleifer A. (1992), "Growth in Cities", *Journal of Political Economy*, n. 100, pp. 1126-1152
- Glaeser E.L. (1998), "Are Cities Dying?", *Journal of Economic Perspectives*, vol. 12, no. 2, pp. 139-160
- Golob T.F. and Beckman M.J. (1971) "A utility model for travel forecasting", *Transportation Science* 5, 79-90
- Graham S. and Marvin S. (1996), *Telecommunications and the City*, Routledge, London.
- Griffith D. A. (1999), "Statistical and Mathematical Sources of Regional Science Theory: Map Pattern Analysis as an Example", *Papers in Regional Science*, vol. 78, n. 1, pp. 21-46
- Hoyt H. (1954), "Homer Hoyt on the Development of Economic Base Concept", *Land Economics*, may, pp. 182-187
- Isserman A. M. (1993), "Lost in Space? On the History, Status and Future of Regional Science", *Review of Regional Studies*, vol. 23, pp. 1-50
- Isserman A. M. (1995), "The History, Status and Future of Regional Science: an American Perspective", *International Regional Science Review*, vol. 17, n. 3, pp. 249-296
- Jaffe A. (1989), "Real Effects of Academic Research", *American Economic Review*, vol. 79, pp. 957-970
- Jaffe A., Trajtenberg M. and Henderson R. (1993), "Geographic Localisation of Knowledge Spillovers as Evidenced by Patent Citations", *Quarterly Journal of Economics*, vol. 63, pp. 577-598
- Kotkin, J. (2000), *The New Geography*, Random House, New York
- Krugman P. (1991), *Geography and Trade*, MIT Press, Cambridge, Mass.
- Long W. (1971), "Demand in Space: Some Neglected Aspects", *Papers and Proceedings of the Regional Science Association*, vol. 27, pp. 45-62
- Longley, P.A., Brocks, S.M., McDonnell, R. and MacMillan, B. (eds.) (1998). *GeoComputation: A Primer*. John Wiley, Chichester
- Lucas R. (1988), "On the Mechanics of Economic Development", *Journal of Monetary Economics*, vol. 22, pp. 3-42
- Maier G. and Sedlacek S. (eds.) (2005), *Spillovers and Innovations – Space, Environment and the Economy*, Springer Verlag, Wien
- Maillat D., Quévit M. and Senn L. (eds.) (1993), *Réseaux d'Innovation et Milieux Innovateurs: un Pari pour le Développement Régional*, EDES, Neuchâtel
- Maskell P. and Malmberg A. (1999), "Localised Learning and Industrial Competitiveness", *Cambridge Journal of Economics*, 23, pp. 167-185
- McCann Ph. (2001), *Urban and Regional Economics*, Oxford University press, Oxford
- Miyao T. (1984), "Dynamic Models of Urban Growth and Decay: a Survey and Extensions", paper presented to the second World Conference of Arts and Sciences, Rotterdam, 4-15 June
- Miyao T. (1987a), "Dynamic Urban Models", in Mills E. (ed.), *Urban Economics; Handbook of Regional and Urban Economics*, North-Holland, Amsterdam, vol. 2, pp. 877-925
- Miyao T. (1987b), "Urban Growth and Dynamics", in Mills E. (ed.), *Urban Economics. Handbook of Regional and Urban Economics*, North-Holland, Amsterdam, pp. 1-41
- Murphy K.M., Schleifer A. and Vishug R.W. (1991), "The Allocation of Talent", *Quarterly Journal of Economics*, vol. 106, pp. 503-530
- Neary J.P. (2001), "Of Hypes and Hyperboles", *Journal of Economic Literature*, vol. 39, pp. 536-561.
- Niedercorn J.H. and Bechdolt B.V. (1969), "An economic derivation of the 'gravity law' of spatial interaction", *Journal of Regional Science*, vol. 9, 273-281
- Nijkamp P. (1975), "Reflections on Gravity and Entropy Models", *Regional Science and Urban Economics*, n. 5, 203-225
- Nijkamp P. and A Reggiani (1999), *The Economics of Complex Spatial Systems*, Elsevier, Amsterdam.
- Nijkamp P. and Mills E. (eds.) (1986), *Handbook of Regional and Urban Economics*, Elsevier Science Publisher, Amsterdam
- Parr J. (1978), "Models of the Central Place System: a More General Approach", *Urban Studies*, vol. 15, pp. 35-49

- Parr J. (1981), "Temporal Change in a Central-Place System", *Environment and Planning A*, vol. 13, pp. 97-118
- Parr J. (1985), "A Note on the Size Distribution of Cities over Time", *Journal of Urban Economics*, vol. 18, pp. 199-212
- Rallet A. (1993), "Choix de Proximité et Processus d'Innovation Technologique", *Revue d'Economie Régionale et Urbaine*, n. 3, pp. 365-386
- Ratti R., Bramanti A. and Gordon R. (eds.) (1997), *The Dynamics of Innovative Regions*, Ashgate, Aldershot
- RERU (1999), *Le paradigme de Milieu Innovateur dans l'économie contemporaine*, *Revue d'Economie Régionale et Urbaine*, Special Issue, n. 3
- Richardson H. (1972), "Optimality in City Size, Systems of Cities and Urban Policy: a Sceptic's View", *Urban Studies*, pp. 29-47
- Richardson H., Button K., Nijkamp P. (with H. Park) (eds.) (1996), *Analytical Urban Economics*, Edward Elgar, Cheltenham
- Roback J. (1982), "Wages, Rents and the Quality of Life", *Journal of Political Economy*, vol. 90, n. 6, pp. 1257-78
- Romer P. (1986), "Increasing Returns and Long-Run Growth", *Journal of Political Economy*, vol. 94, n. 5, pp. 1002-1037
- Roy, J.R. and Lesse P.F. (1981) "On Appropriate Microstate Descriptions in Entropy Modelling", *Transportation Research* 15B, 85-96
- Smith T.E. (1975) "A Choice Theory of Spatial Interaction", *Regional Science and Urban Economics* 5, 137-176
- Smith T.E. (1978) "A Cost-efficiency Principle of Spatial Interaction Behaviour", *Regional Science and Urban Economics* 8, 313-337
- Smith T.E. (1988), "A Cost-efficiency Theory of Dispersed Network Equilibria", *Environment and Planning A* 20, 231-266
- Snickars F. and Weibull, J.W. (1977), "A Minimum Information Principle", *Regional Science and Urban Economics* 7, 137-168
- Stanners D. and Bourdeau P. (eds.) (1995), *Europe's Environment* (The Dobris Report), European Environmental Agency, Brussels
- Toffler A. (1981), *The Third Wave*, Morrow, New York
- WCED (1987), *Our Common Future*, Oxford University Press, New York
- Wilson A. G. (1970), *Entropy in Urban and Regional Planning*, Pion, London
- Wilson A. G. (2000), *Complex Spatial Systems: The Modelling Foundations of Urban and Regional Analysis*, Pearson Education, Harlow

Table 1. Main tendencies in theories and methods of Urban Economics

<i>Spatial principles</i>	<i>Agglomeration</i>	<i>Accessibility</i>	<i>Spatial interaction</i>	<i>Urban hierarchy</i>	<i>Competitiveness</i>
<i>Tendencies in theories</i>					
More realism in theoretical approaches	Efficient city size rather than optimal city size	Endogenous bid rent functions Inter-city location models Absolute vs. differential urban rent Income differences in location choices Externalities in residential location Randomly distributed idiosyncratic tastes Non-uniform generalised cost of travel with respect to location Externalities in land use and social optimum in land use	Search for economic rationale of gravity models Spatial interaction models considering both competing destinations and intervening opportunity factors Computational intelligence approaches to spatial interaction modelling	Aspatial logics behind urban systems	Endogenous growth determinants
Dynamic rather than static approaches	Dynamic urbanisation economies	Dynamic locational choice decisions		Dynamic urban hierarchy models	Cumulative and circular effects in urban growth
<i>Tendencies in modelling and methods</i>					
More refined and advanced techniques	(Bio)ecologically-based models	Discrete models of choice (logit and probit models)	Entropy models Neural networks		Multiple equilibria models Non-deterministic growth models Path dependent growth models
Interest in quantitative measures	Dynamic urban economies measured	Differential vs. absolute rent measured		Dynamic urban network externalities measured	Knowledge spillover measured Endogenous growth determinants measured

Source: Capello and Nijkamp, 2004